# Table of Contents

## Multiple Restraint Systems (MRS I - MRS 4RD)

**Subject** **Page**

# Multiple Restraint Systems (MRS I - MRS 4RD)

## Model: E36, E38, E39, E46, E53, E52 and E83

## Production: All with MRS I, II, III, IV and 4RD

# OBJECTIVES

After completion of this module you will be able to:

- Understand the History of MRS System in BMW Group Vehicles
- Identify MRS System components
- Understand MRS system operation
- Diagnose faults in MRS Systems

## MRS Systems

MRS was introduced as an enhancement of the existing ZAE system. The main improvement was the addition of side airbags with side impact sensors. Also, subsequent versions of MRS introduced such new technology as Head Protection Systems, Battery Safety Terminal, 2 Stage (SMART) airbags and later the introduction of the curtain airbag on the E83.

**E39 with MRS II**

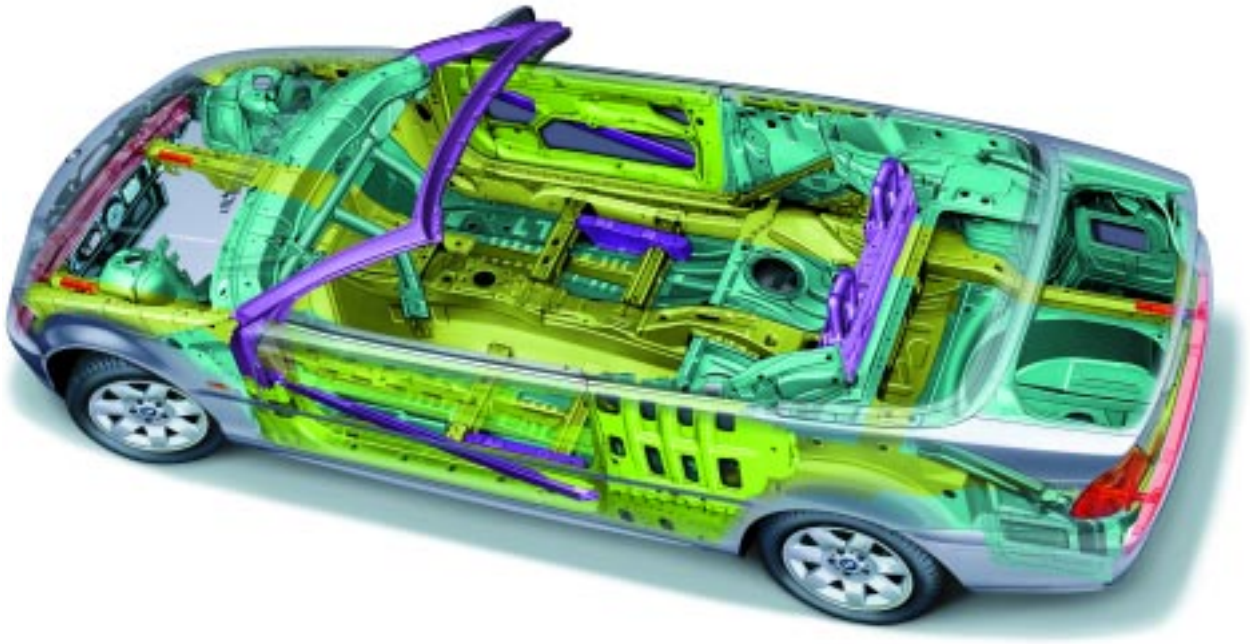

### MRS I

The first version of MRS (MRS I) was introduced with the E39 in March of 1996 and also added to the E38. This system was the first BMW passive safety system to use side airbags with remotely mounted side impact sensors. MRS I remained in use on some models until 9/97 production.

## MRS II

This system was introduced into production vehicles from 5/97 until 9/99. The Head Protection System (HPS) became a standard feature and the option of rear side airbags were also made available. The 2-Stage passenger side airbag was added in September of 1998 and the Safety Battery Terminal (SBK/BST) was also added to protect the vehicle from short circuits to the main battery cable.

**E46 convertible showing reinforced body structures**



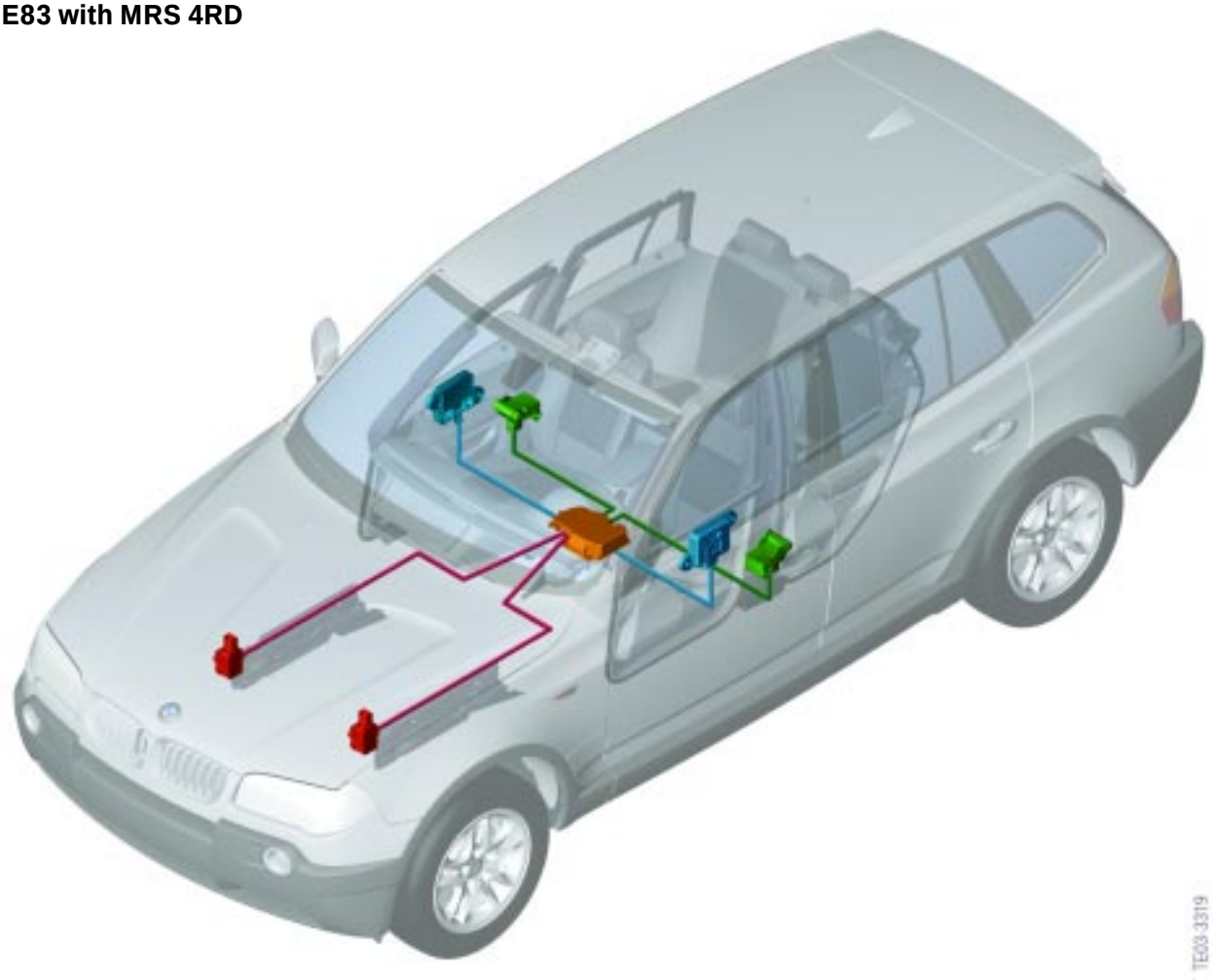
## MRS III

The 2-stage driver's airbag was one of the new items to be introduced with MRS III. Another new innovation was the connection of the MRS module to the K-bus for diagnosis and output of the "crash signal". The K-bus connection also allows the MRS III system to send a fuel pump cutoff signal to the DME. The only exception is the Z3 (E36/7) which does not use the K-bus.

## MRS IV

April of 2001 saw the introduction of MRS IV to the E46 and E53. MRS IV was later phased into production on the E38 and E39 from 8/01. The primary change was introduction of a modified processor with upgraded software for triggering algorithms. Otherwise, all of the features and functions from MRS III are carried over to MRS IV.

**E83 with MRS 4RD**




## MRS 4RD

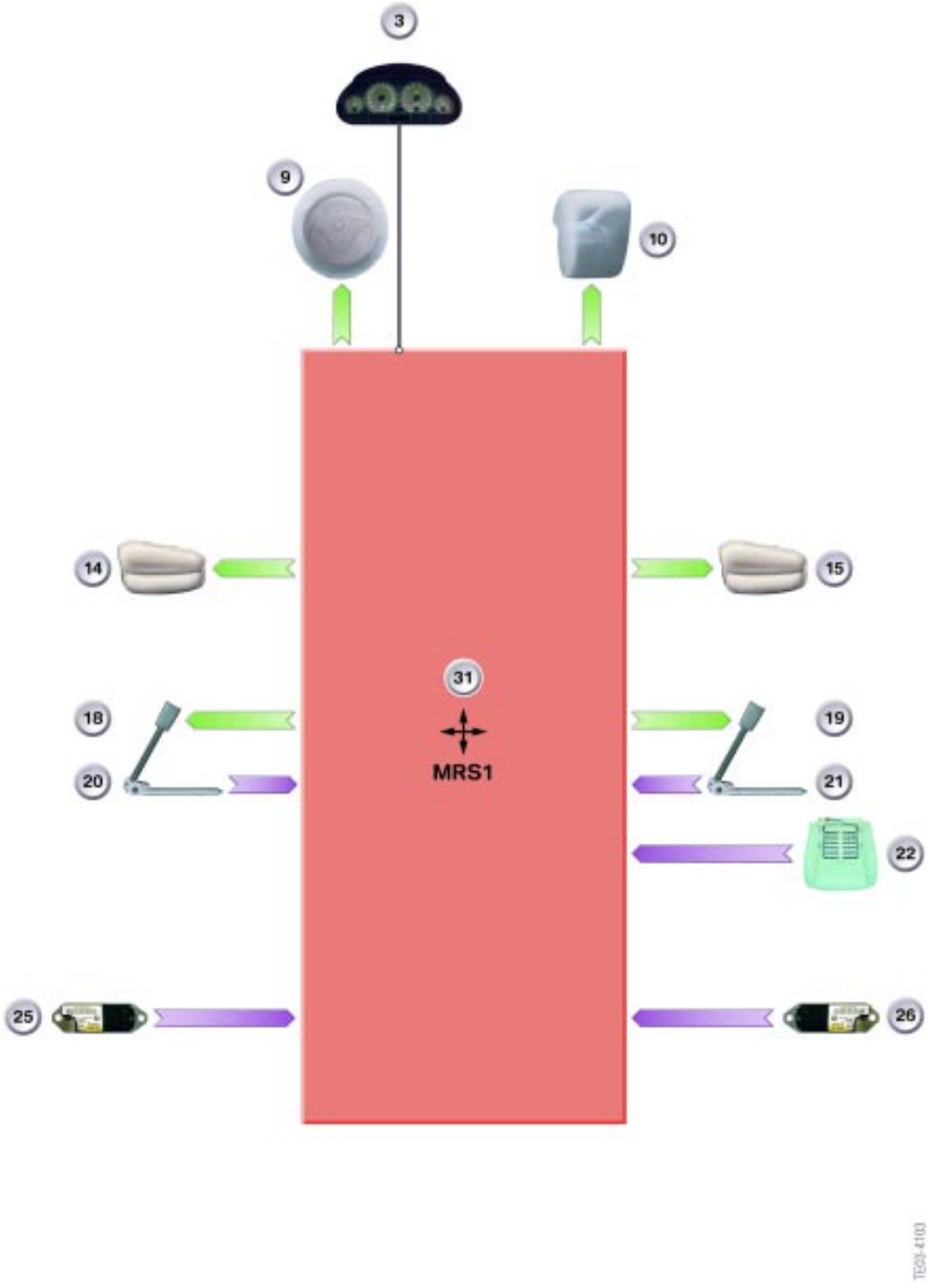
The designation “RD” stands for Redesign of the MRS 4 System. The control module has been upgraded to 75 pins to accommodate new systems and interfaces.
The MRS 4RD system has been optimized with new “up-front” sensors, door compression sensors and b-pillar satellites.

The system also incorporates the new OC-3 Seat occupancy detection system which was introduced on the E60. This system has the capability to automatically turn off the passenger side airbag by detecting the approximate weight and size of the occupant.

## Overview of MRS Features

| MRS System/ Vehicle | Side airbags with Side Sensors | Pyrotechnic Seatbelt Tensioners | HPS Front | HPS Rear | HPS Curtain | Safety Battery Cable (BST) | K-Bus Connection | Up-front Sensors | Door Compression Sensors | B-Pillar Satellites | Passenger Seat Occupancy Detection | 2-Stage Airbags Passenger Side | 2-Stage Airbag Driver's Side |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MRS I E39/E38/E36** | X | X | | | | | | | | | X | | |
| **MRS II E39/E38/E46** | X | X | X | | | | | | | | X | | |
| **MRS II E36** | X | X | | | | X | | | | | X | | |
| **MRS III E38/E39/E53/ E52** | X | X | X | OPT E38 E39 | | X | X | | | | X | X 9/98 | |
| **MRS III E46 (Bosch)** | X | X | X | | | X | X | | | | X | X | X 3/99 |
| **MRS IV E38/E39/E46/ E52/E53** | X | X | X | OPT E38 E39 | | X | X | | | | X | X | X |
| **MRS 4RD E83** | X | X | | | X | X | X | X | X | X | OC-3 | X | X |

## MRS I System Overview

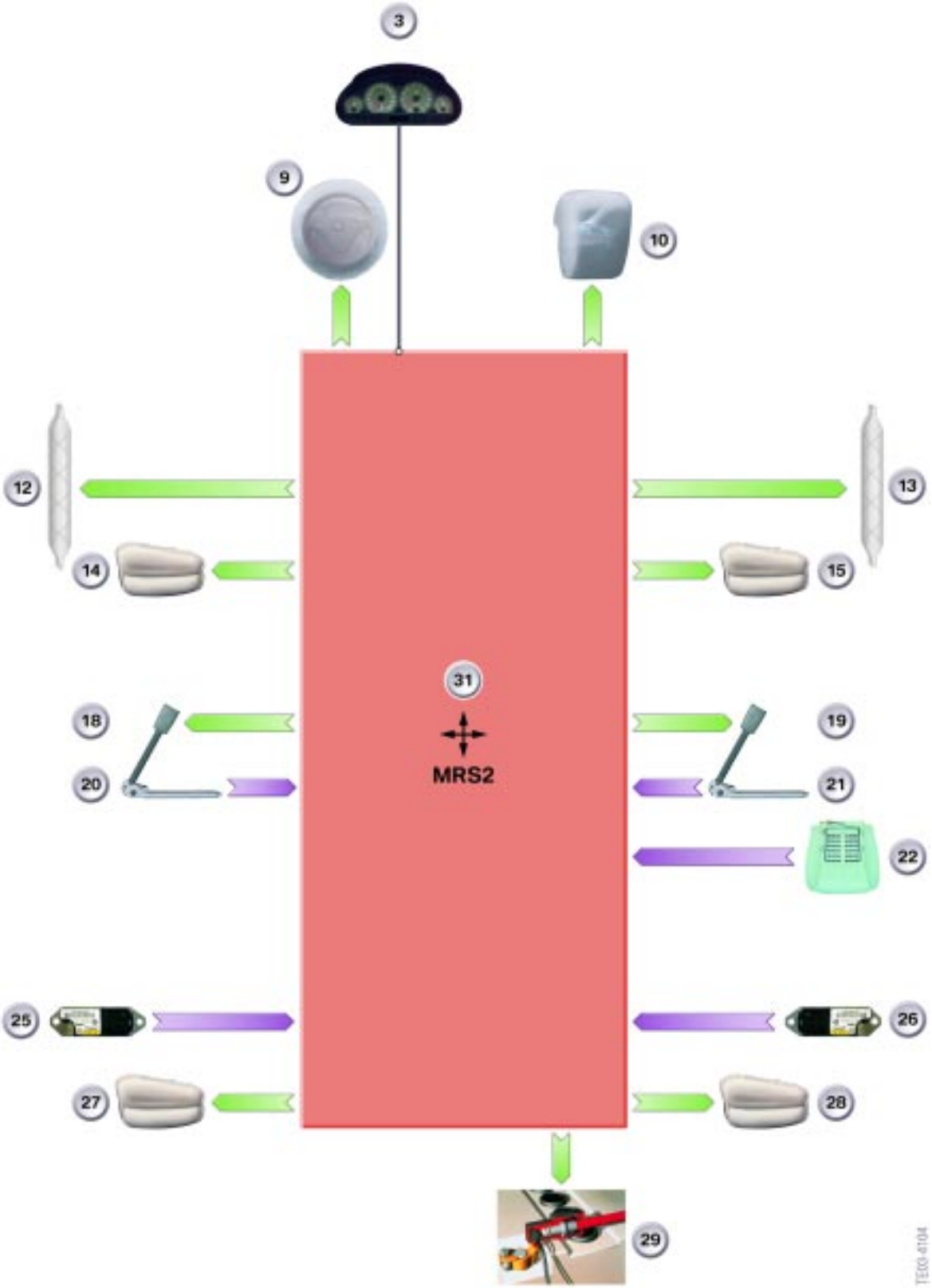


| Index | Explanation |
|---|---|
| 3 | Airbag warning lamp in instrument cluster |
| 9 | Front airbag, driver |
| 10 | Front airbag, passenger |
| 14 | Side airbag, front left |
| 15 | Side airbag, front right |
| 18 | Seal belt tensioner, left |
| 19 | Seat belt tensioner, right |
| 20 | Seat belt buckle switch, left |
| 21 | Seat belt buckle switch, right |
| 22 | Seat occupancy detector (SBE) |
| 25 | MRSA, left |
| 26 | MRSA, right |
| 31 | Control unit |
| CA | Crash output |
| TXD | Diagnostic line |
| KL R | Terminal R |

## MRS I System Summary

- Introduced on the E39 in the 1997 Model Year (96 Production)
- Side airbags with Side airbag sensors
- Passenger seat occupancy detection (SBE)
- Uses pyrotechnic tensioners
- Diagnosis through TXD/RXD
- Control Module is ZCS codeable
- Uses 50 Pin Control Module
- Crash Output signal (to ZKE and LCM)

## MRS II System Overview



| Index | Explanation |
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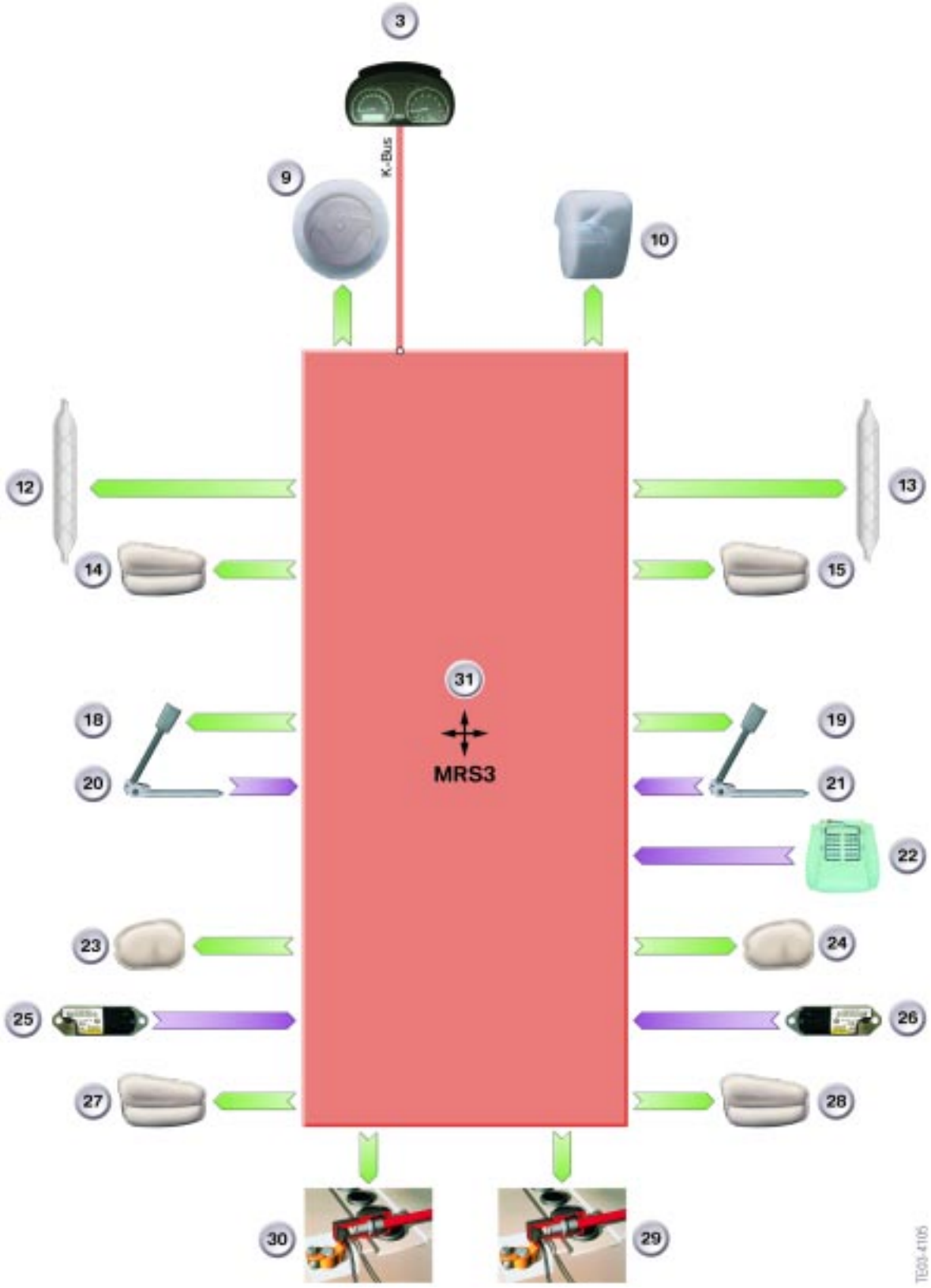
| 3 | Airbag warning lamp in instrument cluster |
| 9 | Front airbag, driver |
| 10 | Front airbag, passenger |
| 12 | Head airbag, left (ITS) |
| 13 | Head airbag, right (ITS) |
| 14 | Side airbag, front left |
| 15 | Side airbag, front right |
| 18 | Seal belt tensioner, left |
| 19 | Seat belt tensioner, right |
| 20 | Seat belt buckle switch, left |
| 21 | Seat belt buckle switch, right |
| 22 | Seat occupancy detector (SBE) |
| 25 | MRSA, left |
| 26 | MRSA, right |
| 27 | Side airbag, rear left |
| 28 | Side airbag, rear right |
| 31 | Control unit |
| CA | Crash output |
| TXD | Diagnostic line |
| KL R | Terminal R |

## MRS II System Summary

MRS II utilizes all of the systems and features of MRS I with the addition of:

- Optional Head Protection System
- Battery Safety Terminal (BST)
- 2-Stage airbag (passenger side from 9/98)
- Uses 50 Pin Control Module (transparent connector)

## MRS III System Overview



| Index | Explanation |
|---|---|
| 3 | Airbag warning lamp in instrument cluster |
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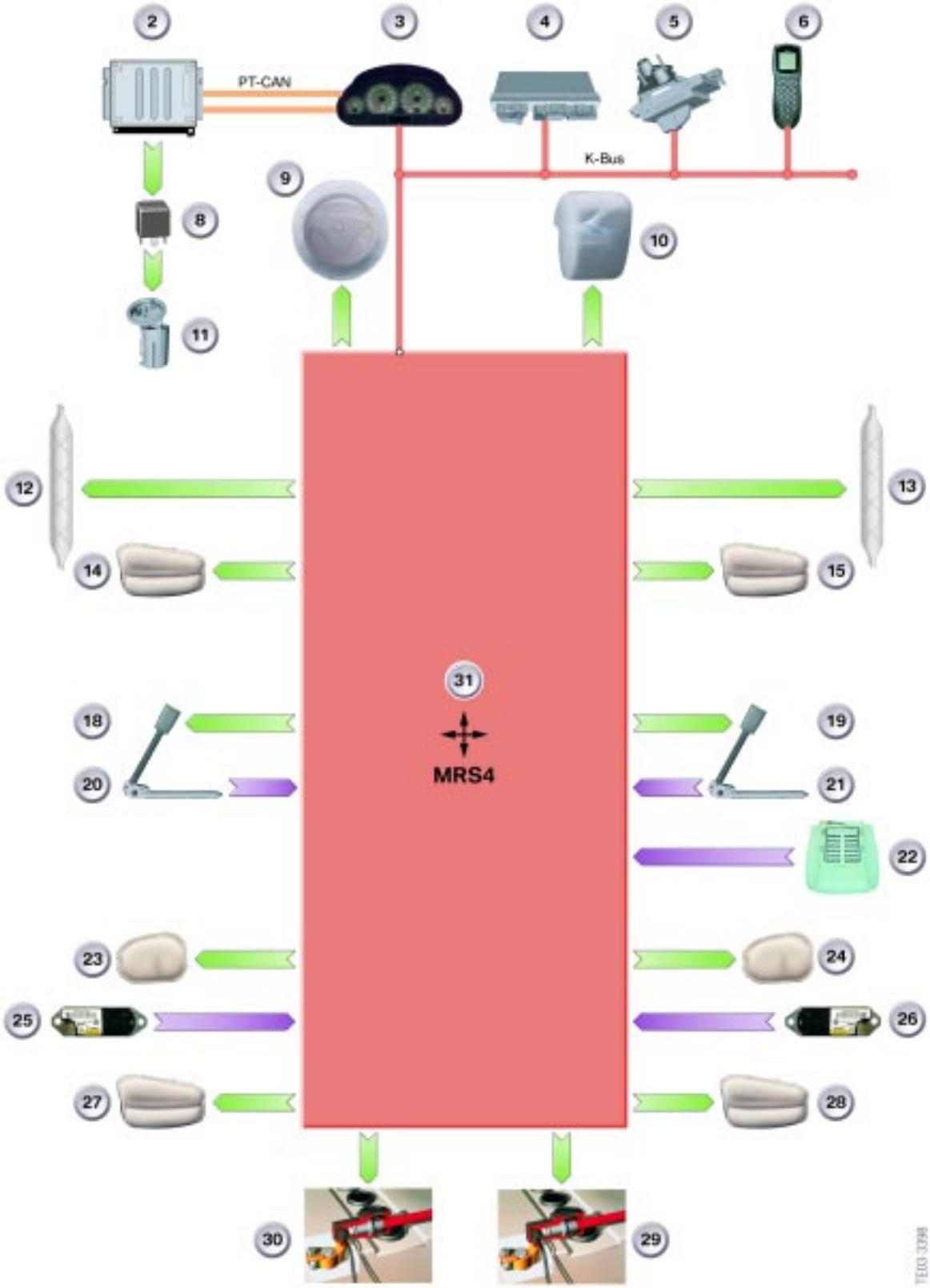
| 18 | Seatbelt tensioner, left |
| 19 | Seat belt tensioner, right |
| 20 | Seat belt buckle switch, left |
| 21 | Seat belt buckle switch, right |
| 22 | Seat occupancy detector (SBE) |
| 25 | MRSA, left |
| 26 | MRSA, right |
| 27 | Side airbag, rear left |
| 28 | Side airbag, rear right |
| 29 | Safety battery terminal (BST/SBK) |
| 30 | Safety battery terminal (BST/SBK) |
| 31 | Control unit |
| CA | Crash output |
| TXD | Diagnostic line |
| KL R | Terminal R |

## MRS III System Summary

MRS III uses all of the systems and features of MRS I and II with the addition of:

- 2-Stage airbag, front driver's side
- Connected to K-Bus (except E6/7)
- Diagnosis via K-Bus (except E36/7)
- Crash output signal via K-Bus (except E36/&)
- Fuel Pump cutoff via K-Bus (to DME via CAN) (except E36/7)
- Optional Rear Head Protection (Rear HPS)

## MRS IV System Overview



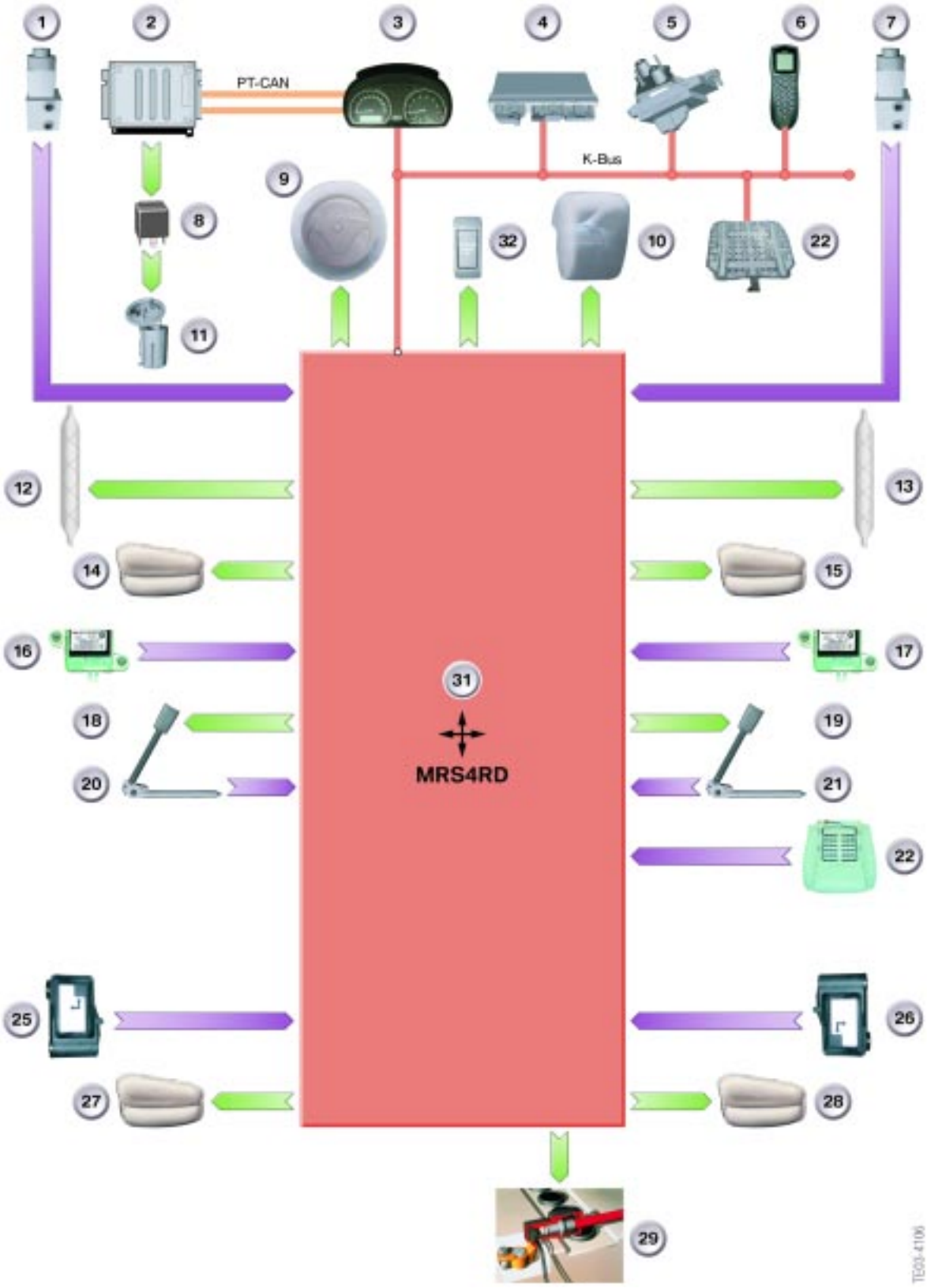
| Index | Explanation |
|---|---|
| 2 | DME control unit (ECM) |
| 3 | Airbag warning lamp in instrument cluster |
| 4 | Base module (General Module) |
| 5 | Light switch cluster |
| 6 | Telephone |
| 8 | Fuel pump relay |
| 9 | Front airbag, driver |
| 10 | Front airbag, passenger |
| 11 | Electric fuel pump |
| 12 | Head airbag, left (ITS) |
| 13 | Head airbag, right (ITS) |
| 14 | Side airbag, front left |
| 15 | Side airbag, front right |
| 18 | Seatbelt tensioner, left |
| 19 | Seat belt tensioner, right |
| 20 | Seat belt buckle switch, left |
| 21 | Seat belt buckle switch, right |
| 22 | Seat occupancy detector (SBE) |
| 23 | Head airbag, rear left |
| 24 | Head airbag, rear right |
| 25 | MRSA, left |
| 26 | MRSA, right |
| 27 | Side airbag, rear left |
| 28 | Side airbag, rear right |
| 29 | Safety battery terminal (BST/SBK) |
| 30 | Safety battery terminal (BST/SBK) |
| 31 | Control unit |
| CA | Crash output |
| KL R | Terminal R |

## MRS IV System Summary

MRS IV uses all of the system and features of MRS I to MRS III with the addition of:

- Modified processor with new software for calculating the triggering algorithm
- Introduced into production on the E46 and E53 in 4/01.
- Phased into the E38 and E39 in 8/01

## MRS 4RD System Overview



| Index | Explanation |
|---|---|
| 1 | Airbag sensor, front left |
| 2 | DME control unit (ECM) |
| 3 | Airbag warning lamp in instrument cluster |
| 4 | Base module (General Module) |
| 5 | Light switch cluster |
| 6 | Telephone |
| 7 | Airbag sensor, front right |
| 8 | Fuel pump relay |
| 9 | Front airbag, driver |
| 10 | Front airbag, passenger |
| 11 | Electric fuel pump |
| 12 | Head airbag, left (ITS) |
| 13 | Head airbag, right (ITS) |
| 14 | Side airbag, front left |
| 15 | Side airbag, front right |
| 16 | Door pressure sensor, front left |
| 17 | Door pressure sensor, front right |
| 18 | Seatbelt tensioner, left |
| 19 | Seat belt tensioner, right |
| 20 | Seat belt buckle switch, left |
| 21 | Seat belt buckle switch, right |
| 22 | Seat occupancy detector (SBE) |
| 25 | MRSA, left |
| 26 | MRSA, right |
| 27 | Side airbag, rear left |
| 28 | Side airbag, rear right |
| 29 | Safety battery terminal (BST/SBK) |
| 30 | Safety battery terminal (BST/SBK) |
| 31 | Control unit |
| 32 | Indicator lamp for front passenger airbag deactivation |
| CA | Crash output |
| KL R | Terminal R |

## MRS 4RD System Summary

MRS IV uses all of the system and features of MRS I to MRS IV with the addition of:

- Introduced on the E83 (2004)
- 75 Pin Control Module with integrated acceleration sensors on X and Y axis.
- Control Module is coded/programmed via CIP
- Utilizes door pressure sensors
- Up-front sensors
- B-pillar satellites
- OC-3 Passenger seat occupancy detection with “Passenger Airbag OFF” indicator

# Components

## Control Module

The MRS control module is centrally located within the vehicle, usually under the center console or rear seat. It contains the crash sensing elements as well as the triggering electronics. The MRS module is also capable of storing up to 10 faults and can be diagnosed through TXD or K-Bus (depending upon version).

**MRS Control Module**
(MRS III Shown)

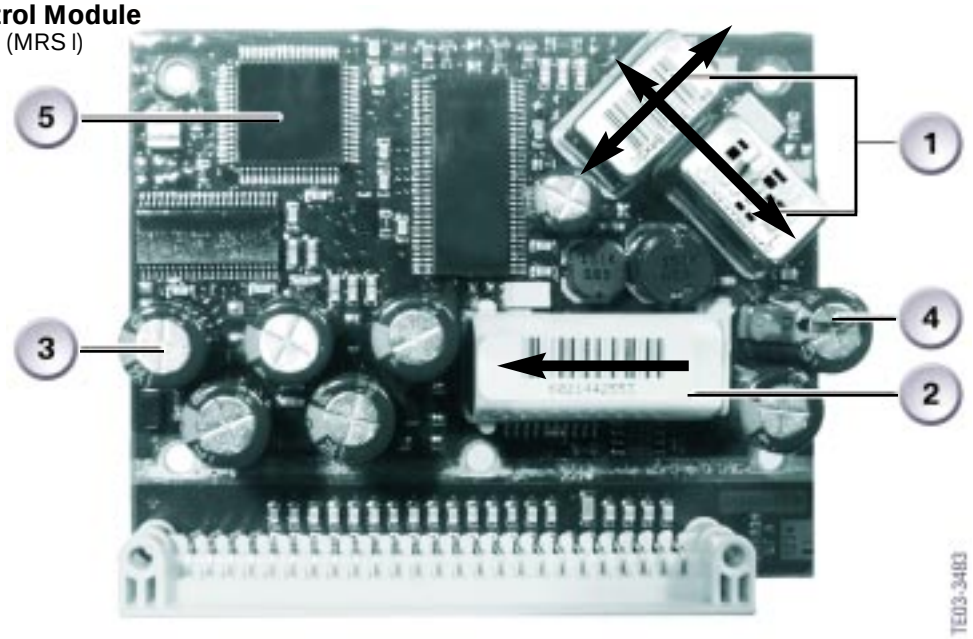

The MRS control unit is responsible for the following functions:

- Crash Identification
- Crash evaluation and triggering of relevant output devices (pyrotechnic devices)
- Performing Self-Check and System Fault Detection
- Display and storage of faults in Non-Volatile Memory (up to 10 faults stored)
- Fault diagnosis through diagnostic link (D-bus, TXD, RXD) (K-Bus from MRS III)
- Control of operation of the Airbag Warning Light (AWL)
- Vehicle specific coding(through ZCS, CIP)
- Activation of crash output signal
- Fuel Pump Cutoff (from MRS III)

All MRS control modules contain internally mounted crash sensors. There are 2 piezo-electronic accelerometers and 1 mechanical safing sensor. The accelerometers are mounted on the circuit board and offset by 90 degrees. Each accelerometer is positioned 45 degrees from the vehicle centerline which, in combination with the side airbags sensors, allows for 360 degrees of monitoring capability. The only exception is the MRS 4RD control unit in which the accelerometers are mounted at 0 and 90 degrees from the centerline of the vehicle.

The mechanical safing sensor uses a small weight which is counteracted by a spring. During an impact, the weight overcomes the spring and makes contact to signal an impact. When an impact is detected by the accelerometers, the airbags will only be deployed if the safing sensor has been triggered.

**MRS Control Module**
Internal View (MRS I)




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Impact detection sensors | 4 | Ignition capacitors with igniter output stages |
| 2 | Mechanical safety sensor | 5 | Microprocessor |
| 3 | Reserve power capacitor with transformer | | |

The airbag module also contains capacitors for energy reserve in the event of power loss during a collision. There are 2 sets of capacitors in use. One set is used for the control module energy reserve and the other is used for the airbag ignition circuit.

The airbag module is capable of storing up to 10 faults in a non-volatile fault memory. Up to 3 impacts can be detected, after which the module will store a non-erasable fault code. Once 3 impacts have been detected, the module must be replaced.

**Note: Be sure to code the module after installation.**

## Airbag Module Summary

Airbag modules between systems are not interchangeable due to hardware and software differences. Most of the early systems use a 50-pin control module, but use different color connectors.

The MRS 4RD system uses a 75-pin module due to additional sensors and peripheral components. Also, the internal acceleration sensors are configured differently. They are installed at 0 and 90 degrees from the vehicle centerline.

Airbag modules should be installed with the directional arrow facing the front of the vehicle unless otherwise noted. Be sure to observe proper torque specifications during installation.


MRS 4RD Shown

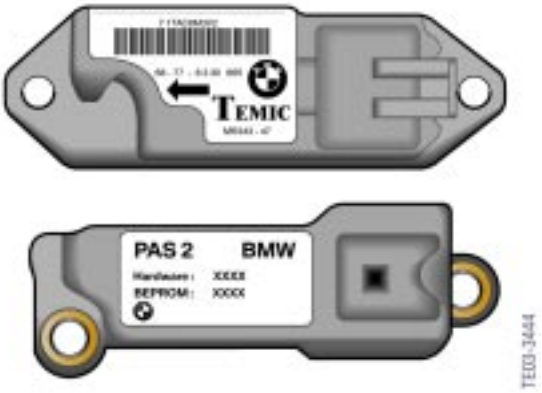
**Note: When servicing airbag systems, always disconnect the battery before attempting any repairs. On vehicles produced before 9/93, disconnect battery and wait at least 30 minutes before starting work. On vehicle produced from 9/93 to present, disconnect battery and wait at least 1 minute before starting work.**

| System | Manufacturer | Pins/Connector | Diagnosis | Comments/Misc |
|---|---|---|---|---|
| **MRS I** | Temic | 50-Pin/Orange | TXD/RXD | Crash Output Signal, SBE |
| **MRS II** | Temic | 50-Pin/Transparent | TXD/RXD | Crash Output Signal, 2-Stage Passenger Airbag, SBE, SBK, HPS |
| **MRS III (E46)** | Bosch | 50-Pin/Grey | K-Bus | Crash Output Signal, 2-Stage Driver's Airbag, SBE, SBK, HPS, Micro-Mechanical Safing Sensor (Bosch), Fuel Pump Cutoff (except E36/7) |
| **MRS III** | Temic | 50-Pin Green | K-Bus | |
| **MRS III (E36/7)** | Temic | 50-Pin Green | TXD/RXD | |
| **MRS IV** | | | K-Bus | Modified processor and new software for calculating triggering algorithm |
| **MRS 4RD** | Temic | 75-Pin | K-Bus | Up-front Sensors, Door pressure sensors, B-pillar satellites, OC-3 with passenger airbag de-activation light, modified internal acceleration sensors |

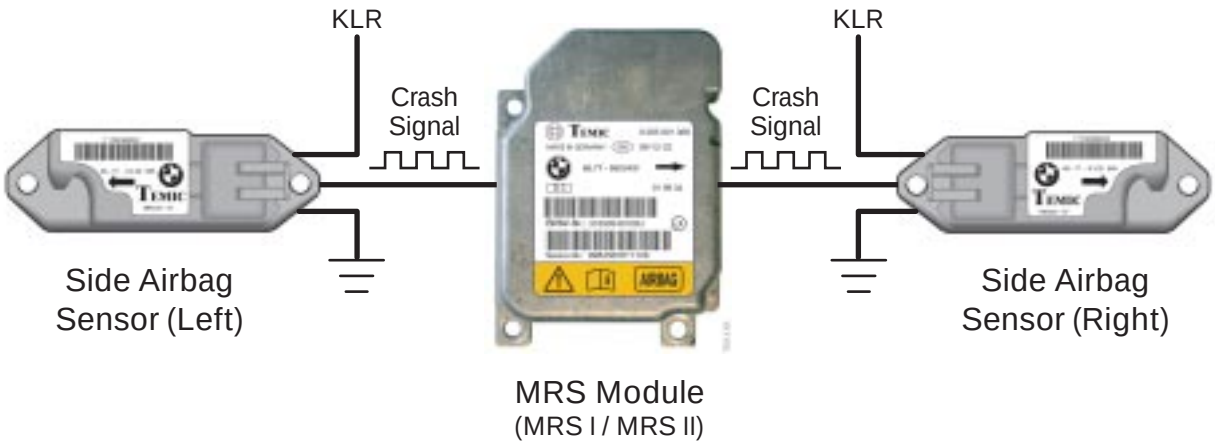
## Side Impact Sensor

In order to record side impacts, the MRS system employs a pair of lateral acceleration sensors referred to as MRSA. These sensors are piezo-electric (accelerometers) sensors which are mounted perpendicular to the centerline of the vehicle. Usually under the front seat supports or mounted in the b-pillar area.

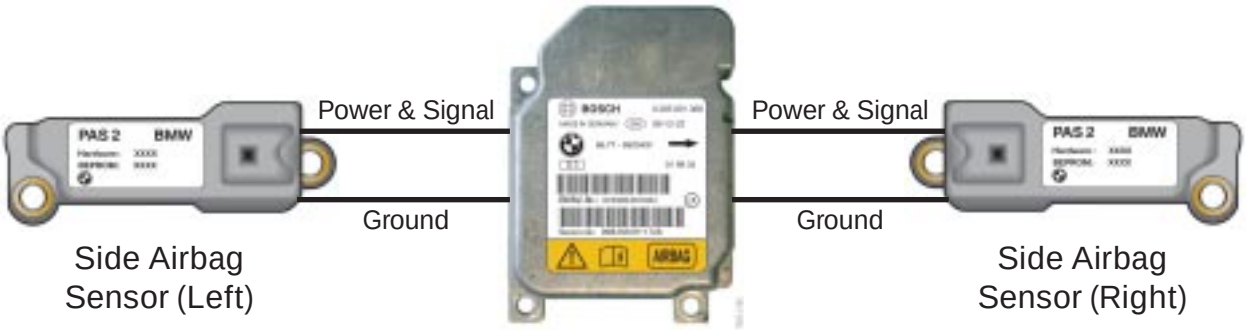
Depending upon application, the side airbag sensors are made by Bosch or Temic. They are not interchangeable.




On MRS1 and MRS 2 systems the side airbag sensors were manufactured by Temic. The connector has 3 pins, one for ground (KL31), one for power (KLR), and the third pin was for the crash signal to the MRS module.



MRS3 and MRS 4 system used Temic or Bosch sensors. These sensors are not inter-changeable and must be matched with the airbag module in use. (i.e. Bosch module uses Bosch side airbag sensor etc.) These sensors used only a two wire configuration. This configuration consists of a ground connection between the sensor and the module, the power supply comes from the module and the signal is transposed over the power supply wire.



## B-Pillar Satellite (MRS 4RD Only)

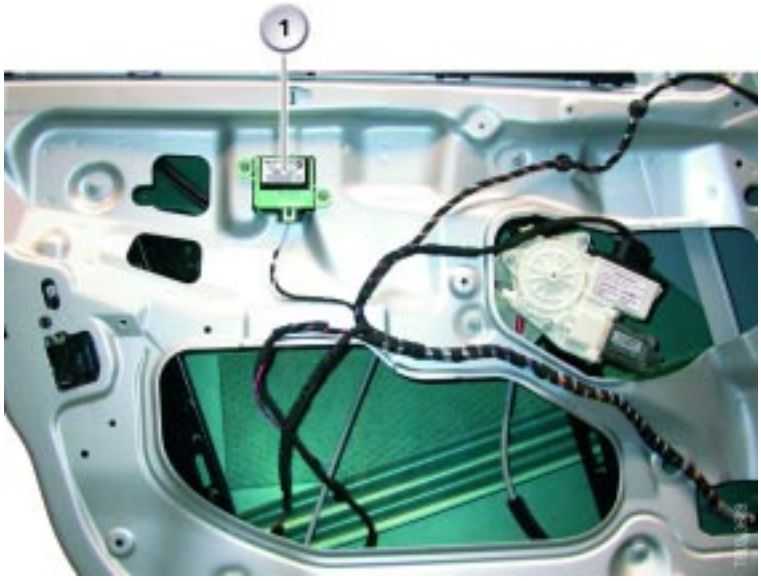
The MRS 4RD system does not use the conventional MRSA side airbag sensors as used on the previous MRS systems. The satellites are mounted near the b-pillar area rather than under the front seats.

The satellites contain lateral as well as longitudinal acceleration sensors. These sensors are capable of detecting impacts from the side as well as front and rear.

The left are right side sensors are the same, the only difference is in the installation. When installed one sensor is directed at the front and right side, the other is directed at the left and rear.

## Door Pressure Sensors (MRS 4RD only)

In addition to the b-pillar sensors, door pressure sensors have been added. This concept, first introduced on the E65, is used to measure the pressure inside the door cavity. In a side impact, the door skin is forced inward in turn reducing the volume. This decrease in volume results in a sudden pressure increase.




This pressure increase is measured by the door pressure sensor and converted to an electrical signal. This signal is passed to the MRS 4RD control module. The control module processes this information along with the corresponding data from the b-pillar satellite. The MRS module activates the appropriate restraint components based on this information.

## Up-Front Sensors (MRS 4RD Only)

The new up-front sensors are used on the MRS 4RD system. The first use of the up-front sensor was on the E60, later the E83 adopted the new sensor technology. The sensors are located on the cooling module assembly above the longitudinal subframe members.


They are used for early detection of frontal impacts. The sensor contains a longitudinal acceleration sensor, a signal converter and a microprocessor for data transmission.

The up-front sensors are supplied with power via a current-signal interface. The sensors are supplied with a current of 5-10mA. When a data message is transmitted, the level increases by approximately 20mA

The advantage of the current signal interface is its constant supply of current which prevents the corruption of the signal. A change of resistance in the circuit does not affect the signal.

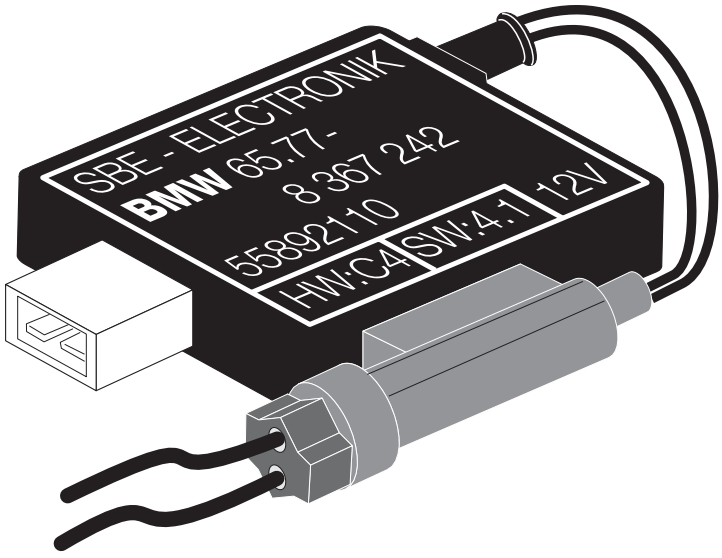
**Note: After an impact in which the airbags have been deployed, the up-front sensors must be replaced. The sensors could be damaged internally, even though no external damage is apparent. Always comply with repair manual instructions when replacing the up-front sensors.**

## Seat Occupancy Detection (all except E83)

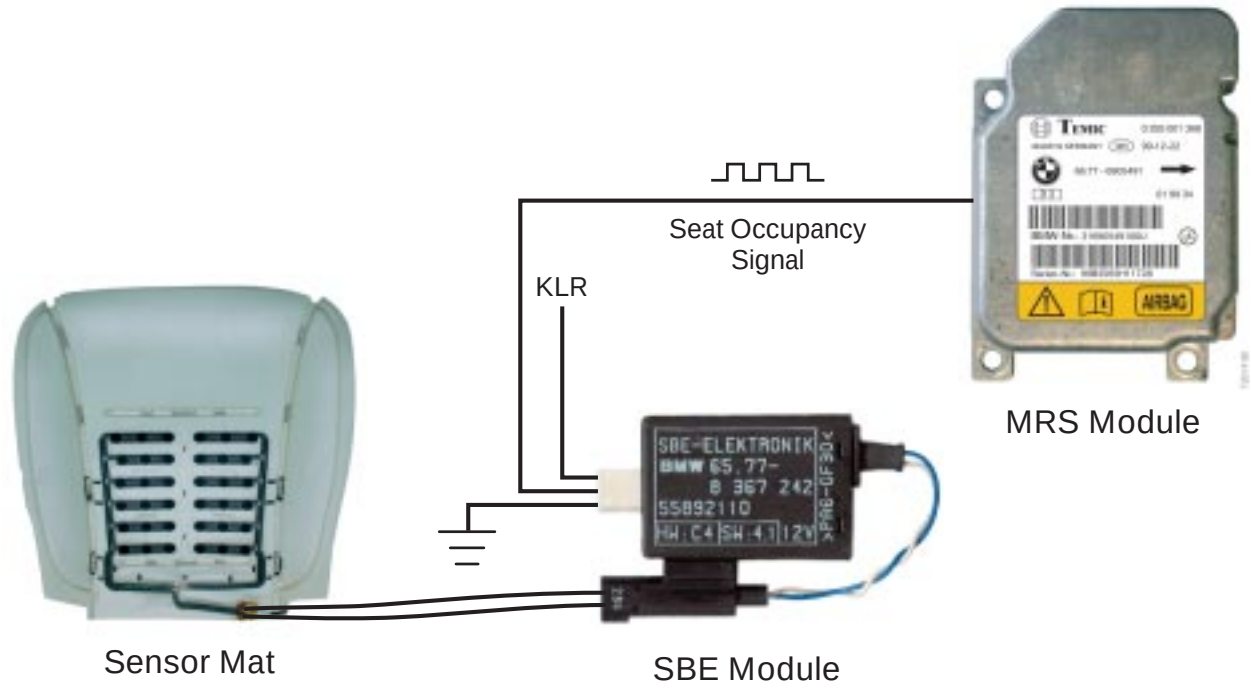
The Seat Occupancy Detection System (SBE), as introduced on ZAE, is continued with MRS systems. The SBE system monitors the front passenger seat for occupants. This information is used by the MRS module to determine airbag activation thresholds.

The SBE system consists of a pressure sensitive resistance mat which is incorporated into the passenger seat cushion.

The SBE module is located under the passenger seat. The analog signal from the SBE mat is converted by the SBE module to a digital signal. This signal is sent to the MRS module via a dedicated signal line. The signal is an “occupied” or ‘unoccupied” message to MRS.



The SBE module sends an digital signal to the MRS module. This signal is dependent upon the status of the front passenger seat (occupied or unoccupied). There is also a 2 minute time delay when the seat becomes unoccupied. This ensures that the airbag will be deployed in the event of a passenger briefly moving off of the seat.

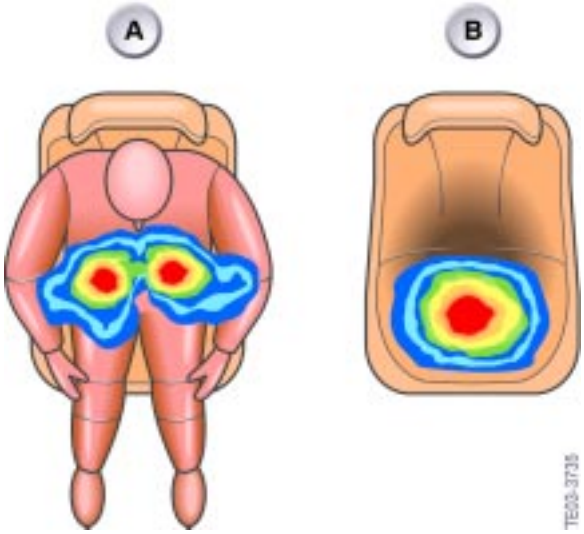



**Seat Occupant Detection OC-3 (E83)**

The need to differentiate between the size and weight of the front passenger has brought about the development of the new seat occupancy detection system. The new system designated “OC-3” (Occupant Classification 3) is capable of determining the approximate size and weight of the passenger.

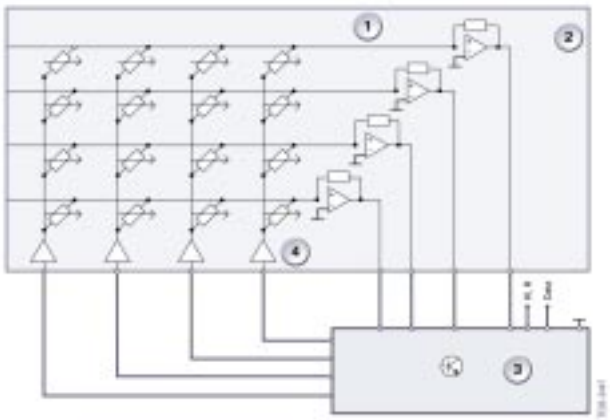
This is accomplished by using a force sensitive resistance mat similar to the previous mat already in use. The OC-3 mat however, uses 4 “resistance zones” which will monitor the concentration and distribution of weight.

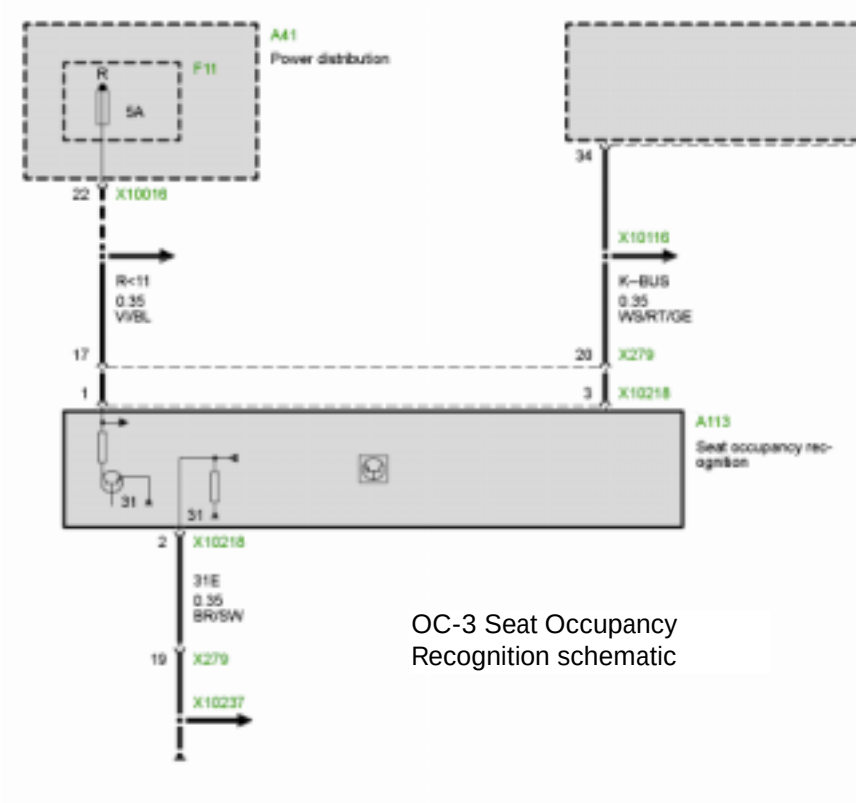
The distance between the concentration of weight indicate whether the occupant is small or large. An algorithm computes the weight class and decides whether the seat is occupied by a person or by a child seat.



The OC-3 mat is connected to an electronic analyzer which is capable of analyzing the information from the resistance mat.

The electronic analyzer is supplied with ground (KL31) and power from KLR. A data line is used to send digital information to the MRS module. On the E83, the electronic analyzer communicates with the MRS control module via the K-Bus




OC-3 Seat Occupancy Recognition schematic

## Workshop Exercise - MRS Inputs

*Using an instructor designated vehicle, locate the MRS module and connect appropriate breakout box and test cable. Observe proper safety procedures when disconnecting airbag module.*

**Attention: Be sure to disconnect battery before checking airbag igniter circuits. When servicing vehicles up to 9/93 production, disconnect the battery and wait at least 30 minutes before beginning any service procedure.**
**On vehicles from 9/93, wait 60 seconds before beginning any service work.**

List the correct part number of the B.O.B. & harness: _____

*Using the correct ETM, locate and list the power and ground connections below:*

MRS Module connector # _____

KL15/R: Pin# _____

Ground (KL31) Pin # _____

List all of the input signals (including pin #) to the MRS module:

_____

_____

_____

_____

_____

_____

Which pin is used for the “crash output” signal?

_____

What systems are affected by the crash output signal?

_____

_____

_____

_____

_____

_____

_____

## Workshop Exercise - Seat Occupancy Detection

*Locate the output signal wire at the SBE module (or electronic analyzer) and connect appropriate test cables. Using the oscilloscope, measure the seat occupancy recognition signal.*

Describe the SBE signal observed and record scope settings: (voltage/ time etc.)

Sit in the passenger seat and describe any changes to the SBE signal:

Vacate the seat and note the amount of time it takes for the SBE signal to change:

Using the appropriate fused jumper wire, ground the SBE signal. Describe what occurs: (i.e. fault code/status requests etc.)

What are the thresholds for the OC-3 sensor are far as weight is concerned?

## Classroom Exercise - Review Questions

1. On an MRS system, how many impacts can be recorded before the MRS module must be replaced?

2. Which MRS system uses door pressure sensors?

   A. MRS 1 B. MRS II C. MRS III D. MRS 4RD

3. What is the safing sensor used for and where is it located?

4. Which versions of MRS systems are connected to the K-Bus?

5. What is the difference between the side airbag sensors (MRSA) and the b-pillar satellites used on the MRS 4RD system?

6. What is the difference between the sensor mat used on the early SBE system and the OC-3 sensor mat?

7. The MRS module contains 2 sets of capacitors. What are the purposes of these capacitors?

8. What type of signal is sent by the up-front sensors when an impact is detected?

## Airbag Warning Lamp (AWL)

On MRS systems, the AWL is used to warn the driver of faults within the airbag system. Each time terminal R (KLR) is switched on, a self test is performed of the internal circuits of the MRS module. Also, the peripheral components (airbags/sensors etc.) are checked as well.

Once this self test is complete (3-4 seconds), the airbag warning lamp goes out. Once the AWL is off, the system is ready to deploy the airbags when needed.

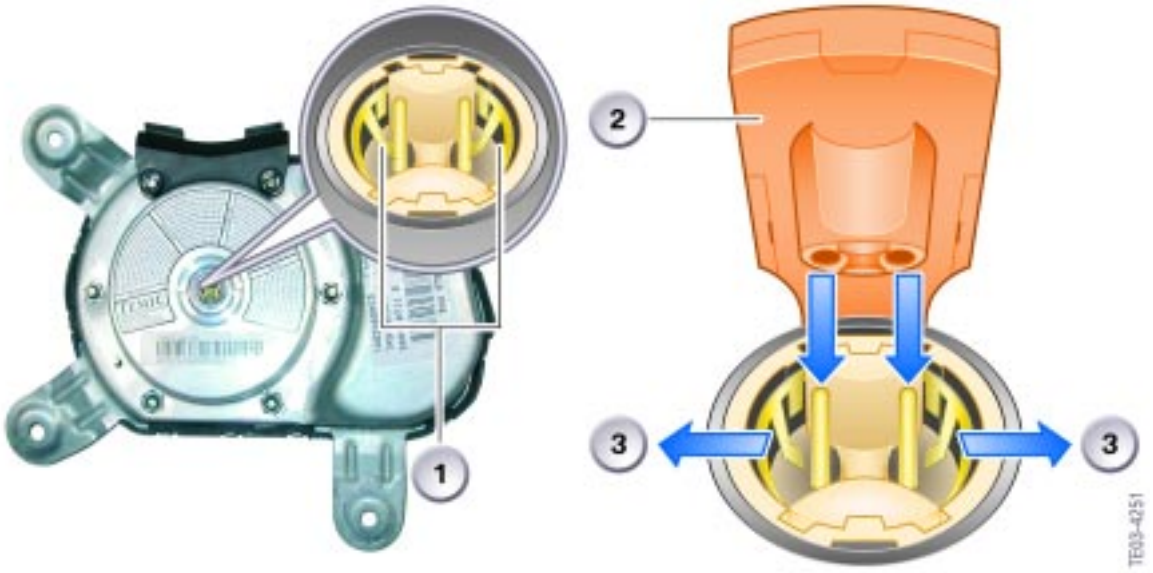
The system is continuously monitored from the time KLR is switched on. If a fault occurs within the system, the AWL is illuminated and a relevant fault is stored. The AWL will stay illuminated (with KLR) until the fault is rectified and fault memory is erased.

The AWL circuit is supplied with with power from KLR/KL15 and the MRS control unit controls the ground side of the circuit to activate the LED in the cluster.

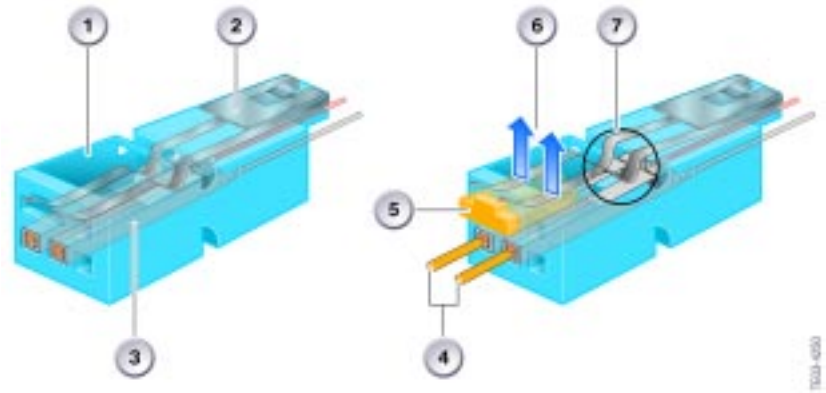

MRS Module

## Airbag Wiring and Connectors

All pyrotechnic components are fitted with a shorting bridge on all plug connectors. This prevents pyrotechnic devices from being accidentally discharged during service work. The shorting bridges create a short circuit across the pins which eliminate the possibility of a voltage potential between the two pins.




| Index | Explanation |
|---|---|
| 1 | Shorting bridge shown in short circuit position |
| 2 | Connector |
| 3 | Shorting bridge (pushed apart by connector) |




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Connector Plug | 5 | Plastic pin on connector |
| 2 | Shorting bridge resting on female contacts | 6 | Shorting bride shown (raised by connector) |
| 3 | Female contacts | 7 | Shorting bridge shown (disconnected) |
| 4 | Male connector pins | | |

During service, when the diagnostic test plan requires a resistance measurement, it is very important to use the correct test cable. This ensures that the shorting bridges are opened. Failure to do so would result in incorrect resistance measurements.

Test cables can be found in special tools (SWZ) in group 61 and 62.

Be aware that the wiring for the side airbag(s) goes through the A-pillar (b-pillar rear) for the firing circuit. This area is susceptible to intermittent connection concerns due to the movement from opening and closing of the door.

B-Pillar Connector E46

**Note: When diagnosing a side airbag igniter circuit, always take into account the condition of the wiring, terminals and connector. These items should be checked first before replacing any components (i.e. Airbag or MRS Module).**

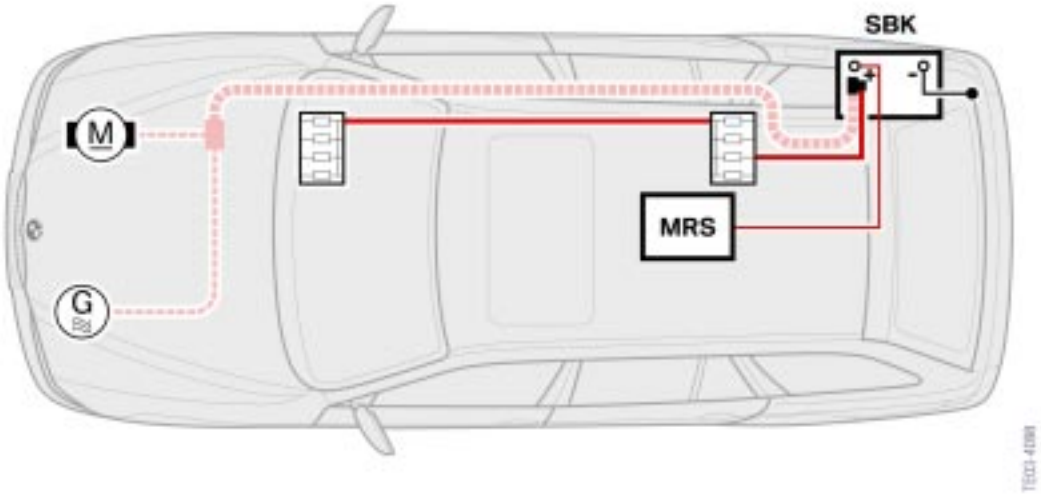
The best way to diagnose this circuit is to perform a wire test (preferred) or a resistance check. The A-pillar connector should be manipulated (wiggled) to check for intermittent open connections.

Repair kits are available for the door wiring harness and vehicle harness.

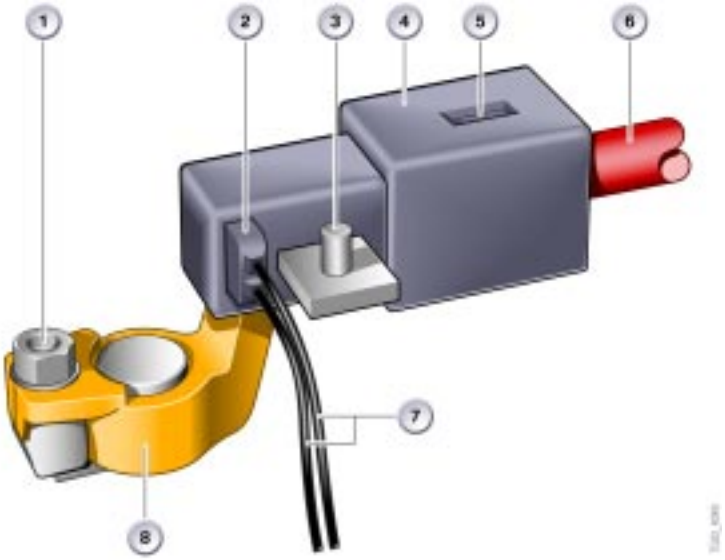
Always check the available Service Information such as Service bulletins and measures as well as the latest repair instructions.

## Battery Safety Terminal

The Battery Safety Terminal (BST) was added to the vehicle electrical system with MRS II systems. Since the battery is located in the rear of the vehicle, there is a considerable amount of unprotected (unfused) cable running from front to rear. The BST is used to protect from short circuit to the B+ cable in the event of a severe impact.




Upon impact the BST will disconnect the B+ cable to the starter and alternator. However the power will remain connected to the power distribution circuits. These circuits are fused and not in danger of an unprotected short circuit. These circuits will remain active after an impact to allow operation of other systems such as power locks, windows and hazard lighting.




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | BST B+ Terminal attaching screw (M6) | 5 | BST Retaining Spring Clip |
| 2 | BST Igniter Pellet | 6 | BST B+ Cable to Starter/Alternator |
| 3 | B+ connection to vehicle power distribution | 7 | BST Igniter Pellet Connection/ 2-wire |
| 4 | BST Plastic Housing | 8 | BST Positive Battery Terminal |

The BST consists of a conventional battery cable terminal which is modified to contains a hollow discharge tube.

One end of the discharge tube contains a small igniter pellet made from a solid propellant. attached to the B+ battery terminal.

The battery cable end has a tapered (conical) connection which is pressed into the battery terminal at the opposite end of the discharge tube.

The BST housing is enclosed in a plastic housing which protects it from damage. The plastic housing contains two plastic spring tabs.

The spring tabs will catch and retain the battery cable connection after deployment. This ensures no accidental contact between the battery cable and the B+ terminal.

Upon deployment, the igniter pellet is triggered by the MRS control module. The resulting gas that is discharged forces the tapered end of the B+ cable to separate from the battery terminal.

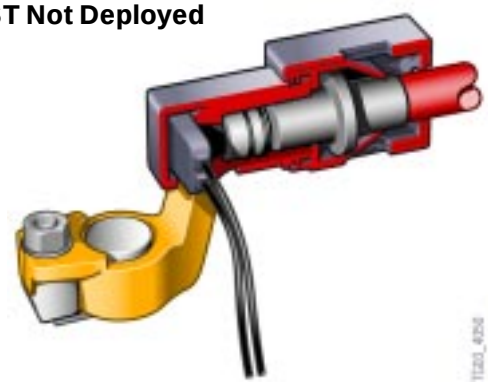
Once the battery cable is separated, the plastic spring tabs will retain the cable.

Once the separation is complete, the starter, alternator and battery cable are now isolated from battery power.

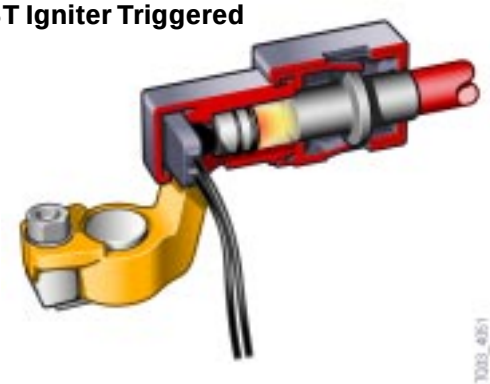
The remainder of the vehicle electrical system is still powered. The power distribution centers are still connected to the battery terminal via a cable.

During a frontal impact the BST is deployed with the front airbags. In a rear impact the BST is deployed at the same time as the seat belt tensioners. If a side impact is detected, the BST is trigger along with the side and head airbags.

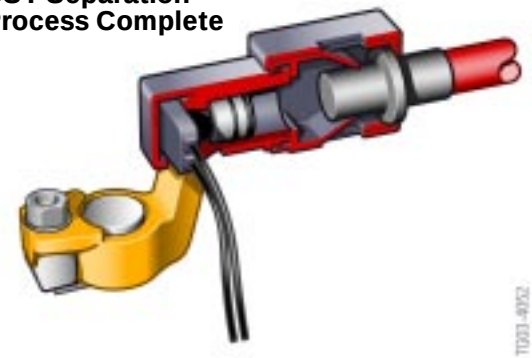
**BST Not Deployed**



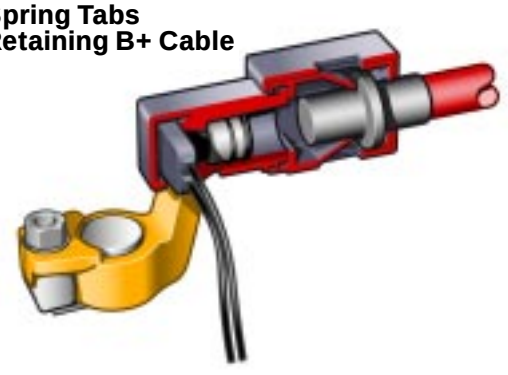
**BST Igniter Triggered**



**BST Separation Process Complete**



**Spring Tabs Retaining B+ Cable**



## Drivers Airbag

The driver airbag,which is mounted on the steering wheel, consists of a tightly folded inflatable cushion constructed of nylon and plastic.

The early airbag systems used a single stage airbag which was deployed by using an ignition squib to ignite a small amount of propellant. This propellant expands, filling the airbag assembly. The airbag deploys by tearing the airbag cover at pre-determined “fracture lines”. The ignited propellant exits the rear of the airbag assembly after being cleaned and cooled through a metal filter in the airbag housing.

**2-Stage airbag front view**

**2-Stage airbag rear view**

The current airbag systems, which have been in use since the 1998 model year, use a 2-stage (Smart) airbag which uses the “cold gas” inflation method. The 2-Stage driver’s side airbag was introduced in March of 1999.

The 2-stage airbag assembly consists of an accumulator/gas generator assembly with 2 ignition capsules. Upon deployment, an inert gas mixture is used to inflate the airbag to a capacity of approximately 64 liters.

The use of two ignition stages, coupled with the lower volume and new propellant, optimizes the deployment of the airbag and makes it less aggressive when the airbag inflates.

**Note: Airbags do not replace conventional safety restraints (seatbelts). When handling an airbag, always place the airbag with the emblem side up.**

## Airbag Contact Ring

In order to maintain contact between the driver's side airbag and the MRS control unit when the steering wheel is turned, a special device was developed. This device is referred to as the contact ring. The contact ring consists of a loosely wound coil of flat ribbon cable.

This arrangement allows the steering wheel to turn approximately 3-4 turns from lock to lock and still maintain the airbag ignition circuit connection. The horn circuit and MFL signals are also routed through separate circuits in the ribbon cable.

**Note: When servicing the vehicle it is important not to turn the contact ring beyond its maximum number of turns, this can result in a broken ribbon cable. For instance, any work involving the steering column.**

**Extra care should be taken to ensure the steering wheel is not turned with the steering rack disconnected. This situation would allow the steering wheel to be turned beyond the capability of the contact ring. Removing the key completely from the ignition is the best way to prevent the steering wheel from being turned inadvertently. Always follow the appropriate repair instructions as they pertain to the contact ring assembly.**

Contact ring disassembled (for demonstration only, DO NOT attempt disassembly. Contact ring will be rendered unusable).

## Passenger Airbag

Passenger airbags have been standard equipment on BMW vehicles since 1993. Just as with the driver airbag, the passenger side airbag uses an inflatable plastic cushion. One difference is that the passenger airbag has a larger inflated volume (105 liters).

Early passenger side airbags also used single stage inflation until 9/98. The “Cold Gas” inflation technique was also used on the 2-stage SMART passenger airbag. The SMART passenger side airbag was installed on MRS II equipped vehicles from 9/98.

**2-Stage Passenger Airbag (Front View)**

**2-Stage Passenger Airbag (Rear View)**

When the front passenger airbag inflates, a flap connected to the dash panel is opened. The flap is retained by a strap, then the airbag opens toward the windshield. When fully deployed, the airbag rests on the windshield and dashboard panel.

## Side Airbag

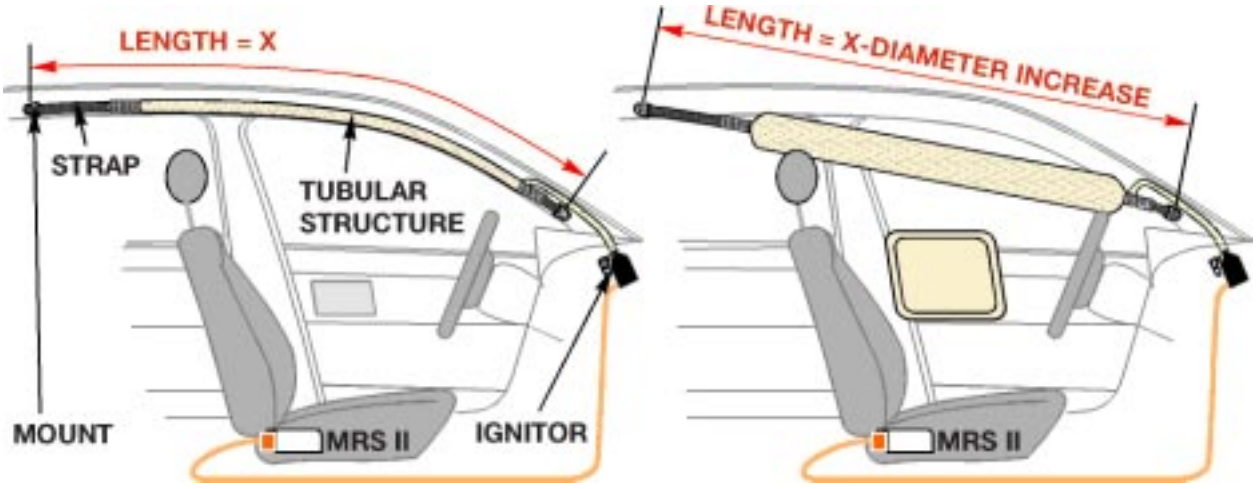
The side airbag is also referred to as the thorax airbag. This is due to the fact the this airbag is designed to protect the thorax (chest/torso) region of the occupant.

The side airbags are mounted on the inner door frame on the front and (optional) rear doors. Deployment of the side airbags is dependent upon the triggering thresholds programmed in the MRS module. These thresholds are determined from inputs from the satellites and internal crash sensors.


## Head Protection Systems

The BMW Head Protection System (HPS) was first used on MRS II systems. It was installed on the E38 in May of 1997 and then added to the E39 in September. HPS was also added to the E46 (Sedan/Coupe) and the E53 as well.

The HPS system consists of the Inflatable Tubular Structure (ITS). The ITS is designed to protect the head and neck of the occupant in side impacts. Head injuries account for a large portion of overall accident injuries. So, the ITS is a natural enhancement of BMW Passive Safety Systems.




The ITS is constructed of an outer woven tube with an inner tube of polyurethane. The woven structure is secured by straps at either end. The straps are secured in the vehicle at the A-pillar and beside the grab handle in front of the C-pillar. The volume of the ITS airbag is approximately 11 liters.

The tubular portion of the ITS is always the same size regardless of application. By altering the length of the retaining straps, it is easy to adapt the ITS assembly in different BMW models.

Upon sufficient side impact, the gas generator in the ITS will be ignited by the MRS module. After ignition, the gas flows through a flexible tube and inflates the ITS. The woven structure will expand causing the overall length of the ITS assembly to decrease. This causes the ITS to exit from the roof and pillar trim.

The ITS will unfold in a diagonal pattern to protect the occupant. The diagonal arrangement is designed to protect occupants of different sizes.

After impact, the ITS is not vented for deflation, it will gradually deflate as the gas cools over a period of time. This process occurs slower than the airbags to protect the occupant from secondary impacts or rollover situations.

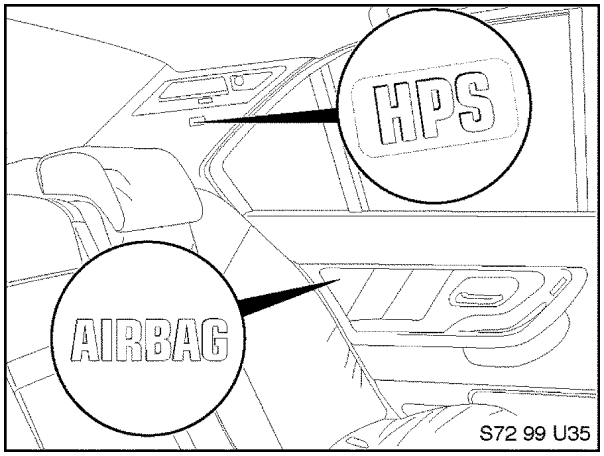
The head protection airbags are always activated together with the side airbags on an MRS II system. On MRS III systems and later, the passenger side (thorax) bag is not deployed if the passenger seat is not detected as occupied.


**Rear HPS**

In addition to front Head Protection, rear HPS optional with the rear side airbag option. Rear HPS is available on E38, E39 and E53.

The rear HPS airbag is a cushion (not an ITS) that is deployed from behind the C-pillar trim. The HPS will not be de-activated along with the side airbags from the factory since there is no danger to small children sitting out of position.

A vehicle with rear HPS can be identified by observing the “HPS” tag embossed in the C-pillar cover.



**Head Airbag (Curtain Airbag)**

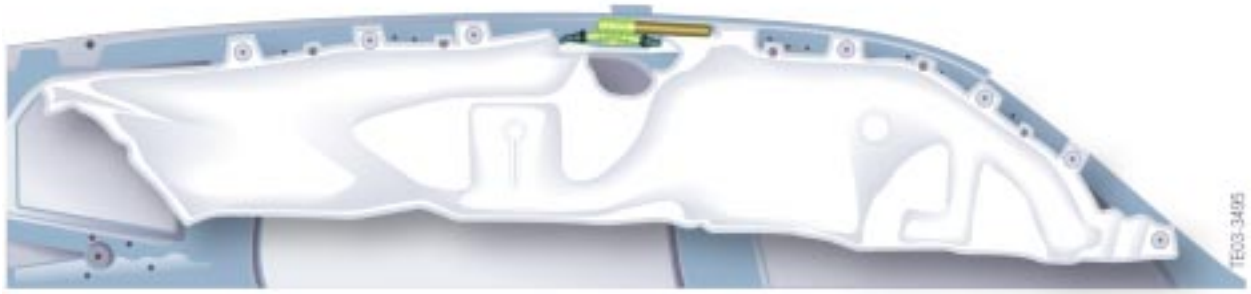
On the E83, a new head protection system , the curtain airbag is introduced as standard equipment for the first time. It differs from the head protection (ITS) previously used. The airbag is now a continuous curtain airbag from the A to C-pillar.

The system covers the entire side window area between the occupants and the vehicle windows and pillar areas. In conjunction with the side airbags in the front and the rear doors, it provides optimum protection for all passengers in the event of a side impact.


The advantages of the system are as follows:

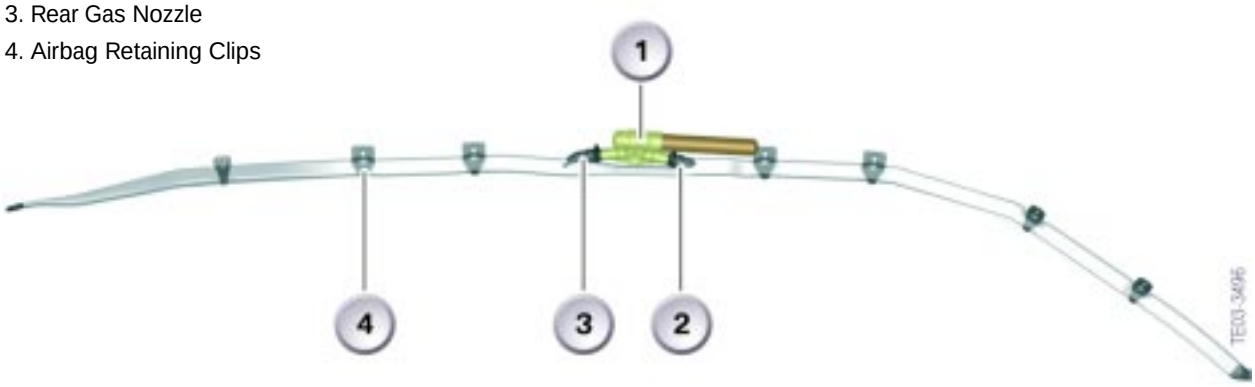
- Extended coverage area for the side windows - front and rear
- Protection against glass splinters and penetrating objects
- Optimized protective area offering protection for occupants of different sizes

The curtain is positioned along the line of the roof side member, folded up. It consists of a gas generator, two gas nozzles and the curtain.




In the event of a side collision, the generator is detonated and the gas flows through the two gas nozzles into the curtain. Simultaneous inflation of the curtain and the front and rear achieves more even deployment.

1. Gas Generator
2. Front Gas Nozzle
3. Rear Gas Nozzle
4. Airbag Retaining Clips




The attachment of the curtain airbag to the A-pillar and C-pillar pulls it into position.

Being a sealed system, the curtain airbag retains its shape and strength for several seconds.

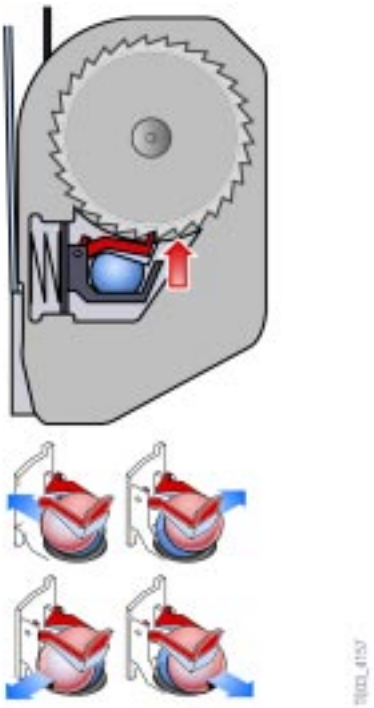
## Seatbelt Tensioning Systems

It has already been proven that 3-point seatbelts offer an unsurpassed level of protection during a motor vehicle accident. However, BMW has added some improvements to increase the level of safety as well as the comfort level of the occupant.

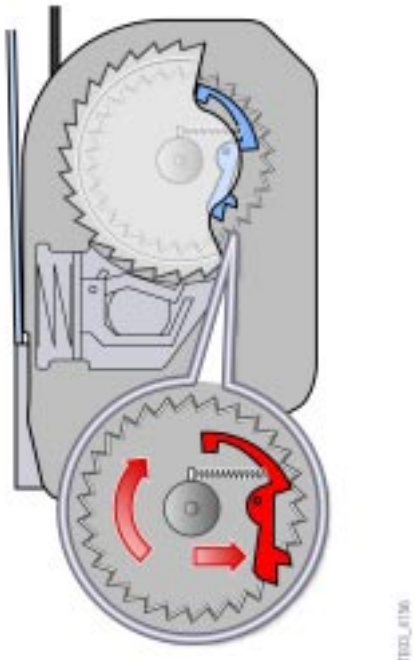
In order to make the seat belt comfortable to wear while driving, the belt must have a sufficient amount of travel to allow movement but the slack must be kept to a minimum. This inertia reel is designed to keep a sufficient amount of tension but to lock under certain conditions.

The inertia reel has two independent locking systems that will lock under various driving conditions. The two locking systems are:

- Ball Type Mechanism - The ball type mechanism uses a ball bearing and lever mechanism which responds to changes in g-force. During extreme cornering, high bank turns, sharp braking and in a collision, the seat belt will be locked in place by the toothed wheel in the inertia reel, the toothed wheel is blocked by the ball and lever assembly.
- Centrifugal Mechanism - The centrifugal mechanism will lock the seatbelt when it is pulled quickly from the reel. This can be demonstrated by jerking the seat belt out of the reel quickly, the seat belt should lock immediately and then unlock once the belt is released and pulled out slowly.



**Ball Mechanism**



**Centrifugal Mechanism**

## Pyrotechnic Seatbelt Tensioners

The inertia reel mechanism is designed to minimize the amount of belt slack, however this does not take into account the elasticity of the seat belt. Also, the seating position and the thickness of the occupants clothing must also be considered.

To counteract these possibilities, BMW has installed a pre-tensioning mechanism to reduce the slack in the seat belt during an impact.

Once an impact of sufficient severity is detected, the gas generator in the pre-tensioned will tighten the seat belt approximately 55mm.

This will prevent the occupant from sliding under the seatbelt, an effect referred to as “submarining”.

This ensures that during an impact, the upper body will shift forward which improves the effectiveness of the airbag.

There are 4 types of seat belt pre-tensioning devices used in BMW vehicles. On MRS equipped vehicles, the pre-tensioners in use are the pyrotechnic type.

The pyrotechnic seat belt tensioned consists of a seat belt buckle attached to a steel cable. The steel cable is fitted to a piston at the end of the cable. The piston is installed in a steel tube which contains a small amount of solid propellant.


1. Before Accident
2. After Accident

Upon impact, the propellant is ignited and the piston is driven down the tube. This in turn pulls the steel cable which pulls the seat belt buckle downward.

After an accident where the pre-tensioners are deployed, they must be replaced.

## Seat Integrated Belt Systems (SGS)

The SGS system is used on vehicles that do not have a b-pillar post. The first vehicle to use the SGS seat was the E31. Currently, the E46 convertible and the E64 use the SGS seat.

All seat belt attaching points including the upper anchor point are integral to the seat frame. All of the forces in a collision are absorbed by the seat frame and the floorpan.

The SGS seat allows the best possible seat belt geometry in relation to the occupant. The seat belt is wrapped tightly around the occupant irrespective of seat position and body size. This helps reduce the amount of free seat belt length and also further reduces excessive slack.

The features of the SGS seat are as follows:

- All of the seat belt attachment points are connected to the seat frame.
- The inertia reel clamps the seat belt at the closest possible point to the occupant.
- Optimum protection of occupants in the event of a collision.
- Seat belt strap is released when the backrest is folded or adjusted.
- Comfort is maximized by allowing ideal body restraint for any seat setting or body size.
- Restricted forward displacement of occupant due to additional seat belt strap tensioner.
- More protection during rear and side impact.
- No “submarining” effect.
- Ideal solution for vehicles without b-pillar

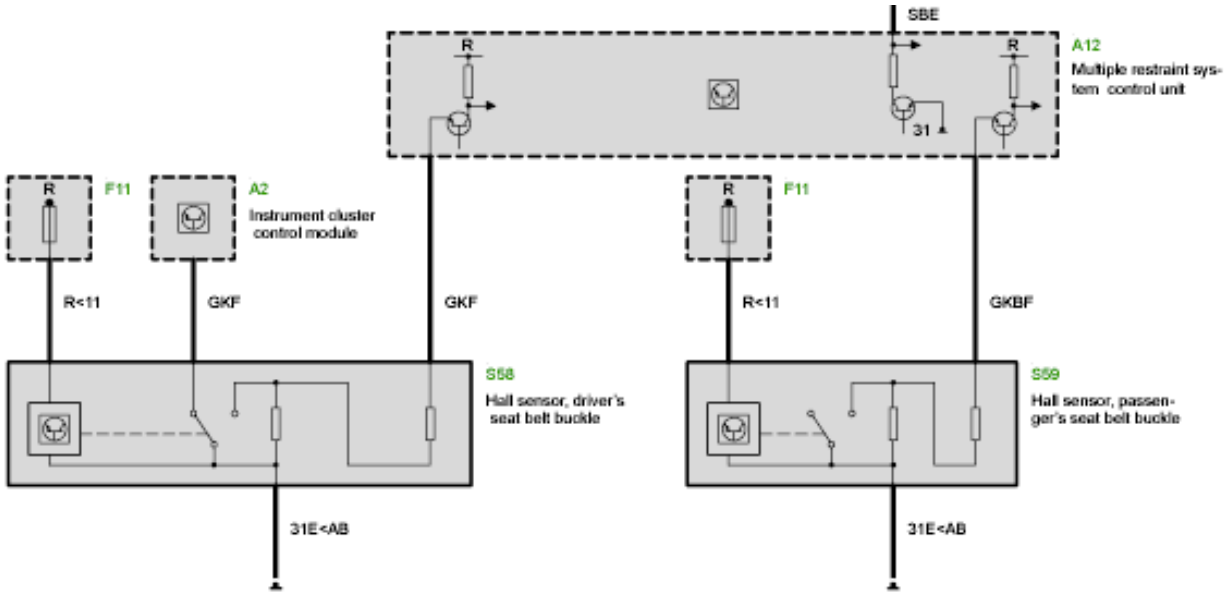
## Seat Belt Contacts

Regardless of seat type or tensioning device used, all seat belt buckles have a switch mechanism. The seat belt buckle switch has a dual purpose. The switch reports seat belt status to the MRS module for the purpose of trigger logic. The MRS can then actuate the necessary pyrotechnic devices (e.g. belt tensioner, airbags etc.)

The seat belt is also used for the seat belt warning light. This feature will illuminate the seat belt warning light if the vehicle is started without the seat belt being fastened.

Early seat belt mechanisms used a mechanical type switch. Later models adopted a hall-effect switch to increase reliability.

The hall-sensor buckle switch has been in use on most models since March of 1997.



## Workshop Exercise - Checking Airbag Igniter Circuits

*Using an instructor designated vehicle, check the following airbag circuits:*

**Attention: Be sure to disconnect battery before checking airbag igniter circuits. When servicing vehicles up to 9/93 production, disconnect the battery and wait at least 30 minutes before beginning any service procedure. On vehicles from 9/93, wait 60 seconds before beginning any service work.**

*From the MRS module connector, check the resistance of the side airbag circuits.*

What is the observed resistance? _____

*Using the "resistance tool" supplied by the instructor, apply an increasing amount of resistance until the AWL is illuminated.*

What is the minimum resistance required to illuminate the AWL?

_____

With the increased resistance in place, perform the applicable test module as per DISplus/GT-1 instructions.

What does the test module conclude as the root cause?

_____

_____

_____

_____

What does the test module state as the correct resistance range for the side airbag circuit?

_____

*From the MRS module connector, check the resistance of the driver's side airbag (both stages):*

What is the resistance observed?

_____

# Principle of Operation

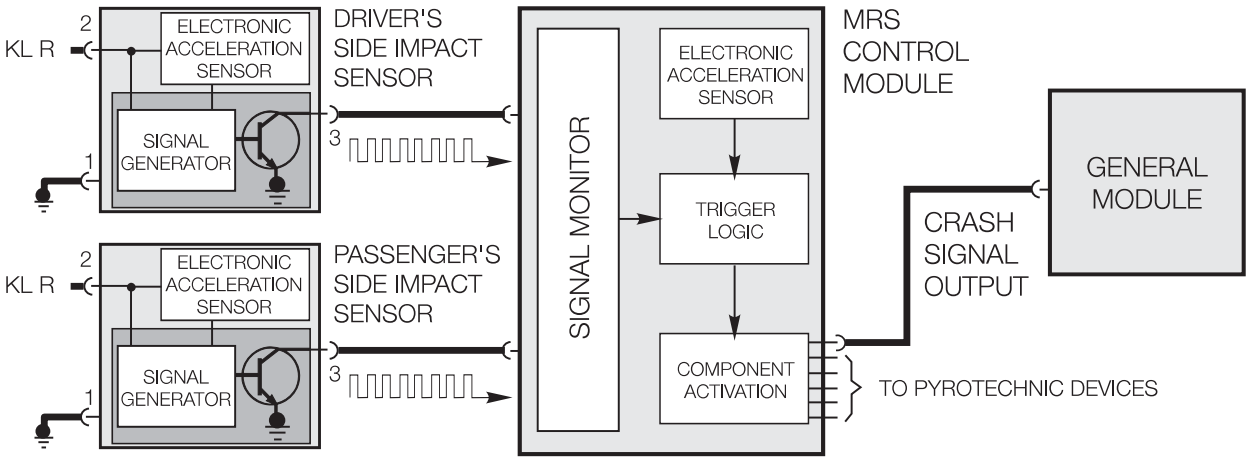
## Crash Output Signal

The Crash Output Signal (CA) is an output of the MRS control module. In the event of an impact, various systems will by activated to facilitate access by rescue personnel. The door locks (if locked) will be unlocked, the interior lights will be turned on and the hazard warning flashers will be activated.

To accomplish this, the MRS module sends a “crash output” signal (CA) to various systems within the vehicle. Depending on the vehicle model and system fitted, the crash signal will be a 12 volt high/low signal or a bus telegram over the K-Bus.

The body electronic system (ZKE III, IV or V) receive the crash signal for the activation of the locks and interior lights. The lighting system (LCM or LSZ) also receives the crash signal for activation of the hazard lights.

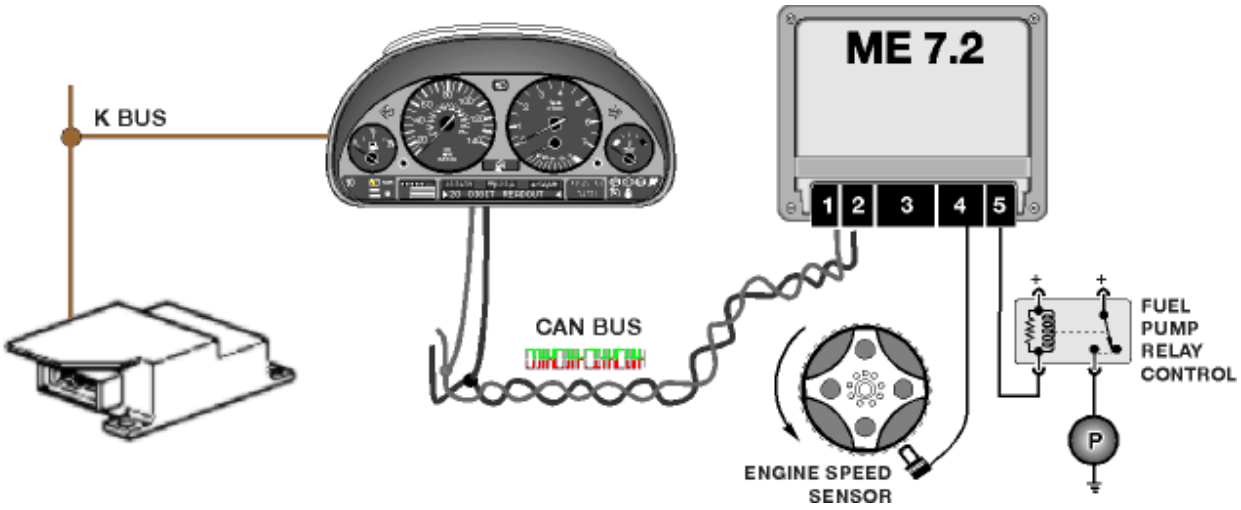
Crash signal on vehicles without K-Bus



## Fuel Pump Cutoff Circuit

Beginning with MRS III, the fuel pump operation will be de-activated during an impact for added safety. The MRS module sends a “crash message” over the K-bus. This K-bus message is processed by the cluster and sent to the ECM via the CAN bus.

The ECM interrupts fuel pump operation by de-activating the control circuit of the fuel pump relay.



## SOS/Emergency Call

Beginning with the 2004 3 series and the X3, the SOS/emergency call feature can now be initiated by the MRS control module via the K-bus. Upon airbag deployment, the MRS control module will send a K-bus telegram to the Telematics Control Unit (TCU) to send an emergency call.

The new TCU is equipped with GPS capability that allows the vehicle to be located by emergency personnel.

## Workshop Hints

### Checking Airbag Resistance

When checking airbag resistance, always use the correct test cable. This ensures that the shorting bridges are disconnected. Failure to do so will result in improper resistance readings during testing.

### Repairing Airbag Wiring

As a general rule, airbag wiring is not to be repaired unless specified in a service bulletin or outlined in repair instructions. There are some repair kits available in the parts system. These are usually for side airbag ignition circuits.

### Airbag De-activation

### De-activation of Airbags (front and front side)

On certain vehicles, it is possible to de-activate the front passenger and front side airbags and the rear side airbags upon customer request.

As far as the de-activation of the front passenger airbag is concerned, refer to BMW Service Information Bulletin (SIB) B 72 08 97. All of the necessary regulations and procedures are outlined here.

To deactivate the passenger side airbags (and rear side airbag), a special code will need to be obtained from BMW NA. The “special code” is used in ZCS/FA coding to properly de-activate the specified airbags.

The bulletin also outlines the proper forms to be used. The customer will have to fill out a necessary disclaimer/authorization form for this.

The forms are then faxed to BMW NA via the BMW center. The necessary fax numbers are also outlined in the SIB.

### De-activation of Airbags (rear side)

On some vehicles, the customer may request to have the rear side airbags de-activated as well as the rear HPS (not recommended).

In response to this some vehicles produced from 6/99 (E38, E39 and E65) come from the factory with the rear side airbags de-activated and disconnected.

Therefore in order for the side airbags to be active, the customer must fill out the necessary forms and have the rear airbags re-connected and re-activated via coding.

Refer to BMW SIB B 72 03 99, which contains all of the necessary procedure.

## Classroom Exercise - Review Questions

1. What are the two purposes of the seat belt contacts?

2. What is the purpose of the shorting bridges in the airbag igniter circuits?

3. What is unique about the head protection system on the E83 (X3)?

4. What airbag system was the first to use BST?

5. Which MRS systems have the capability to cut-off the fuel pump operation in the event of an impact?

6. What vehicles are equipped with the SGS seat and why?

7. Why is there no venting on the ITS assembly?

8. When diagnosing an igniter circuit on a side airbag, what should be considered BEFORE replacing any airbag components (i.e. MRS module or side airbag)?

9. Which MRS systems are equipped with HPS?

10. What are the two types of locking system mechanisms used on the inertia reel?

11. What is the approximate resistance of an airbag igniter circuit?

12. What precautions should be observed when performing repairs to the airbag contact ring or surrounding components?

**Review Notes:**